3 1761 07488436 2

EcC
M6893

Modern business lectures.

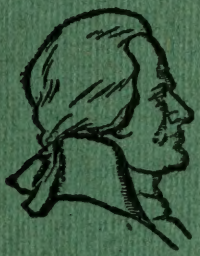
No.1,3-10, 12,13, 15-17, 19-24

Ecc
M6893

[Modern Business Lectures]

COST AND EFFICIENCY RECORDS

By HARRINGTON EMERSON



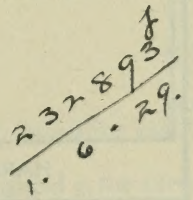
MODERN BUSINESS
LECTURE No. 10

ALEXANDER HAMILTON INSTITUTE
NEW YORK

Cost and Efficiency Records

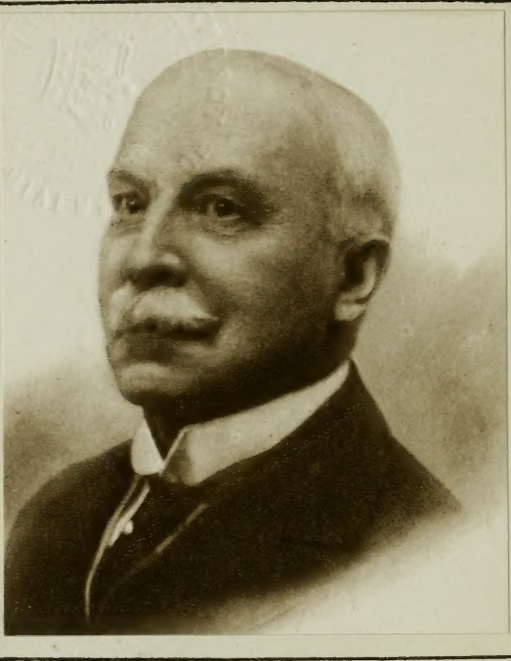
By HARRINGTON EMERSON

One of a Series of Modern Business Lectures
Especially Prepared for the
Alexander Hamilton Institute



ALEXANDER HAMILTON INSTITUTE
NEW YORK

Copyright, 1914, by Alexander Hamilton Institute
" 1917 " " " "
Copyrighted in Great Britain in 1914
" " " " " 1917
All rights reserved



HARRINGTON EMERSON

HARRINGTON EMERSON

Harrington Emerson was born at Trenton, New Jersey. Between the ages of 9 and 23 he traveled in Europe, Africa and Asia. He attended a variety of schools and became familiar with many nationalities, languages and governments. He was graduated from the engineering course of the Royal Polytechnic at Munich, Germany, with an A. M. degree.

From his 23rd to his 45th year, Mr. Emerson was on the American frontier from the Mexican border to Northern Alaska, subsequently being appointed to investigate a number of American manufacturing plants and other operating enterprises for a London syndicate. This gave him exceptional opportunities for study and observation.

A little later Mr. Emerson was made manager of a small manufacturing plant, which up to that time had been unsuccessful. The enterprise was of a type to which basic principles of control and development could easily be applied. The results were great and convincing. In this capacity he still further proved the soundness of his theory that principles, rather than methods and devices, are of importance in the management of an enterprise.

Then came an opportunity to apply the theory on a large scale in the case of the Santa Fé railroad. Here he was confronted with the task of applying scientific principles to the work of some 12,000 mechanical employes on fully 10,000 miles of road, reaching into twelve states. The result of this work has now become history.

Upon completion of the Santa Fé undertaking, Mr. Emerson opened a consulting office in New York, associating with himself therein a number of able men.

Since 1906 this company has been engaged in the advocacy of efficiency principles and efficiency methods and in giving counsel as to applied efficiency work.

Mr. Emerson is a member of the American Society of Mechanical Engineers, Ingénieurs Civil de France, Efficiency Society, American Railway Master Mechanics Association, American Economic Association, American Foundrymen's Association, several other technical societies, and of the Boston City Club, and the Railroad, Engineers and Aero Clubs, of New York.

NOTE:—This Lecture, which is based upon the author's ripe experience in his special field, should be read in the light of the Modern Business Text, and should be studied as an authoritative message from the field of present-day business activity.

Cost and Efficiency Records

On my eighth birthday I was given a jackknife, for which I had long yearned. Because it was my birthday I stayed home from school and as the dull morning wore on I felt a burning desire to try out the jackknife and therefore started to carve my initials on top of the mahogany parlor table.

Absorbed in this task, I was suddenly brought back to reality by an irate father, almost speechless with indignation, who demanded what I was doing with that knife. I flippantly answered that I thought a jackknife was made to use. For a few seconds there was a strenuous scrimmage, from which I emerged unable to sit down comfortably, and minus the jackknife—which was confiscated for a month.

When it was returned to me, a task accompanied it. I was to split fine a bundle of kindling. I started in with considerable zeal, but in a few minutes grew weary of the monotonous and inefficient task. I blistered the palm of my hand, and I thought how useless my work was, since the fire could be kindled almost as well with the unsplit sticks.

In my bitterness I wished I had never seen the jackknife. Nevertheless, I was learning to use it, and altho I did not know it, perhaps this was the reason I had been given the hateful work.

But I found other uses for my knife. An older boy showed me how to make from the despised kindling a "Figure-Four" trap. A mouse had been seen in our dining room. I made a little trap, baited it with cheese and set it up under the edge of an inverted china washbowl. In the morning the trap was sprung, a mouse was under the bowl, but when I lifted it, he managed to escape, and had put in the night trying to gnaw his way out thru the carpet. As my trap had been set across a seam, two breadths of carpet were ruined. I was told that if I ever showed the jackknife inside the house again, it would be permanently confiscated.

With my next trap, set under a box in a field, I caught and secured a wild rabbit. That was an efficient piece of work. I also made a small kite, and borrowing, without asking, my mother's spool of strong linen thread, I actually flew my handiwork almost out of sight. Suddenly the thread broke, not far from my hand, and the kite fluttered down into some woods, so that not only did I lose the kite, but I was unable to return the linen thread as I had most firmly "intended."

In the spring, I used my jackknife to make whistles from the bark of weeping willow twigs. I cut the twig the right length, notched it, shaped the mouth end, quickly beat the bark with the knife handle until it could be slipped off the wood. I cut off the top of the core, and, flattening one side, put in the

mouth end. The balance of the core slipped up and down in the bark tube, thus enabling me to make a great variety of shrill notes, delightful music to my ears.

In the traps which caught wild rabbits, fleeter of foot than I, in the kite which soared almost out of sight while I myself could scarcely jump two feet, in the whistles which delighted me with their shrill music, I was using efficiently my precious jackknife.

In carving the parlor table I had been strenuous, but neither systematic nor efficient. In cutting kindling I was systematic, but neither strenuous nor efficient; but in making toys I was, first of all, efficient, but also when necessary both strenuous and systematic.

Three Ways of Operating

All business, and also every tool, instrument or method used in human activity, can be operated strenuously, systematically or efficiently, even as I and my jackknife were in turn strenuous, systematic or efficient.

Cost and Efficiency Records are an instrument. They can be used strenuously to little purpose, they can be used systematically and yet, with a maximum of effort and toil, accomplish only a minimum of result; or they can be used efficiently and accomplish a maximum result with a minimum of effort.

An eight-year old boy and a new jackknife is a dangerous combination. It should not have been turned loose. I should have been backed into a

corner and sternly asked what I intended to do with a jackknife; in fact, it should have been withheld from me until I had a definite purpose. When I had assembled the objects I intended to carve and slash, then and not until then should I have received the equipment wherewith to accomplish; and I should have been given to understand that I was responsible for maintaining the ideal or aim; that I was responsible for the execution of the plans and for the use of the equipment. Boyhood lessons are lessons for life's problems.

The Units of an Industrial Organization

In industrial life a powerful aggregation does not consist in methods and devices, nor yet in men, materials, machines and money; not even in an organization. It consists always in a combination of spiritual, intellectual and material equipment; conceiving, acting and achieving.

Mr. Henry Ford has manufactured and sold more automobiles than any other living man. It was just a few years ago since he started with only an idea and with infinite personal effort built his first car.

The city of Detroit, whose prosperity today rests upon the automobile industry, promptly passed an ordinance forbidding Ford to run his car except in the hours between midnight and 4 a. m. Today Mr. Ford has an immense organization and stupendous equipment, but the man who made the business was Mr. Ford with his definite aim, and with the executive ability to carry it out.

A great executive like Henry Ford will, as his instinct and experience prompt, adopt one of three types of management with which to govern his organization and his equipment.

The three types of management are:

(1) The strenuous individual type.
(2) The systematized type.
(3) The efficiently aggregated type.

The Strenuous Individual Type

Strenuous individuality denotes the way most things start, from the kicking of a baby to a young railroad. Some men never outgrow their boyhood. They remain individualistic. This type of management, beginning in the small enterprise, often continues into the larger concerns. Tho new conditions arise, there is an aversion toward relinquishing former customs and methods.

Concerns which adhere to primitive types of management are fore-doomed to death. They rarely outlive the original founder.

The Systematic Type of Management

In Prussia, a systematized country even forty years ago, they permitted four official religions: Reformed, Lutheran, Catholic and Jewish. When I was filling out a census blank for my father's family I demurred at the limitation, my father being an American clergyman, but I was severely told that there were only these four varieties of

religion, and that I had to choose at once or be fined. I acquiesced and chose.

At Havana, after the American occupation in 1898, a young doctor was in despair because Washington, instead of filling his requisitions for medicines and supplies, kept sending them back for correction—he was using the wrong blank, made entries in the wrong column, etc. In the meantime, soldiers were dying for lack of proper medicine and supplies, and what was worse, a good man, filled with energy and initiative, was converted into an indifferent and hopeless place holder.

The tendency of System is inevitably in this direction. System is born of precedent, is devoted to precedent, cannot free itself from precedent.

Efficient Aggregated Management

Efficiency management differs from strenuous and from systematized management in that it subordinates both individuals and system to broad general principles. The successful individual is generally strenuous. Strenuousness means a very great effort for a very small gain. Efficiency means a very great gain for a greatly lessened effort.

If a man walks five miles an hour for one hour, he is more tired than if he had walked four miles an hour for three consecutive hours. As to the single hour he has gained twenty-five per cent; but measured in fatigue he has made five miles instead of twelve, he has accomplished fifty-eight per cent less.

If four miles an hour is too slow for a man, give

him a bicycle. He will, with no more effort than is required to walk two miles an hour, ride ten miles an hour. He goes twice as fast as when most strenuously walking, he goes five times as fast as when giving the same effort to walking.

The Aims of Efficiency

Strenuousness is often an excellent quality; it enables us to set rational standards, generally one-half the speed of extreme effort. System also has its place, but it should always be subservient to efficiency and not attempt to curtail initiative. Efficiency aims to accomplish more by using less effort. These are the premises that underlie modern cost and efficiency records.

The aims of cost and efficiency records are:

(1) To tie factory operations into the controller's records.

(2) To show the standard cost of each operation.

(3) To show the efficiency of each operation as to cost, time and quality.

(4) To show the actual loss of money and time as to each item of material on each operation.

Any cost system that does not fulfil reliably, immediately, adequately and permanently all these four essentials is deficient.

Controlling is a form of supervision elaborated during many centuries. In the earlier stages the controller wanted to know what the pay-roll was, what the bills for material were and what the sales were. If the sales in a decade were greater

than the bills of all kinds for the same decade the difference was considered profit. This was the method of the Hudson's Bay Company.

In a large western plant only a short time ago, this form of industrial accounting was in use. The manager of the plant was complaining that he was losing money because his monthly sales were less than his monthly bills, and he was unwilling to take any account of the fact that a vast quantity of manufactured product had been put in storage awaiting shipment.

Misleading Cost Figures

In another plant, one of the largest in the world, we were checking up monthly expenses. In one of the departments we had ascertained the average for May, June, July and August, had effected some changes in September and confidently predicted a reduction in cost of one dollar a ton on an output of 2,000 tons in October.

With considerable glee the controller showed us that in October there was no reduction in cost per ton. Amazed and disconcerted, we checked over the items and discovered a six-months' water bill of over $2,000 which had been accumulating since the previous April and had been paid in October and charged against the tonnage cost that month.

The plant costs were indeed tied into the controller's records, but not in a way to be of help.

In another plant, making structural iron work, during many years the average cost per ton had been

ascertained. Most of the work had been large beams with few rivet holes and a small amount of fitting. A large contract offering a successful bid was made on the basis of past average experience as shown by the controller's records.

This job, however, consisted of pieces of small weight, requiring much fitting and many rivets. It cost per ton almost five times as much as the controller's average, and despite most strenuous endeavors the contract netted a severe loss.

An Attempt at Efficiency

Methods as crude as these are still common. To remedy crudities of this kind, the controller of a western railroad investigated shop conditions. As to labor he found:

(1) That men of low skill were taken on by corrupt foremen as high grade men at high grade wages which the men divided with the foremen.

(2) That men were reported by the foremen as present and paid accordingly when in reality they were either non-existent or absent, in each case the foreman or some other official profiting by the deception.

(3) That there were no records showing how expenses were to be apportioned to different classes of work, no method even of ascertaining the average cost of repairs of locomotives per mile or per locomotive, or of freight cars per mile or per car.

The auditor therefore installed a system by which (1) Every man had to be classified either as

journeyman, apprentice, handy man or helper, and standard rates of pay were agreed to, for each man was supposed to do work corresponding to his class.

(2) Each man was checked in at 7 a. m. and checked out at 6 p. m. This, it was hoped, would save paying wages to absentees.

(3) Each man was asked each day how many hours he had worked on each kind of job the previous day, and his convenient and uncertain memory was thus made the fundamental record.

Weaknesses of the New Method

Undoubtedly this system was an improvement over the earlier easy-going unchecked procedure. What actually happened, however, was this. Men holding cards as journeymen, but of personal incompetence, were taken on and rated side by side with men of competence and diligence. A corrupt foreman would favor the incompetent man, since this one favored him by bribing him in various small ways; but he would dread the competent man and would make (not find) an excuse for running him out of the shop.

The men checked in on time, but I have known cases where whole gangs, for days at a time, did very little work. They hid away, kept out of sight, many of them even leaving the plant after checking in and returning to check out. When asked what work they had done the day before, their imagination dictated the answer; and in a special case $5,000 of labor was charged up against the easily remembered

number of an unfortunate locomotive that was waiting three months for a repair part to come from the East.

The system did stop some abuses and therefore was an improvement over the preceding anarchy; it did answer the first requirement of the controller, that the shop figures should tie into the controlling accounts.

False Logic

The false logic of the earlier method, which is still prevalent, is to generalize from the whole to a part, to apply data fairly sound for a ten-year period to a year, to a month, to a week, to a day, to an hour, to a single operation.

This is no more sensible or reasonable than to use the yearly average temperature and rainfall of a place as the weather probabilities for an outing. It is evident that under this idiotic plan December and July would have the same probabilities.

The false logic of the improved method is to imagine that correct final results can be obtained from inaccurate elements.

Both methods are failures because they generalize from an unreliable whole to a part; they rest on the assumption that expense and cost are identical. Because a man on the same trip buys a cigar and loses a hundred dollar bill thru a hole in his pocket, it does not follow that the cigar has cost $100.25, yet this is exactly the kind of cost accounting that prevails in some of the largest corporations.

Many of the most progressive and largest concerns, from the railroads under the Interstate Commerce Commission down thru the great corporations, are bound in the red tape of elaborate cost systems which are wholly incapable of giving real efficiency records.

This is inevitably so because the cost accountant is not usually capable of setting up standards (new standards arising every month); and, being a staff man, he is as a rule also incapable of realizing standards, which is the business of the line officials following out the plans evolved.

Prime Requisites

The first requisite of a cost system is that the same fundamental record shall answer the needs of the controller, of the efficiency engineer and of the executive line official.

The controller wants to know where every cent goes as promptly and with as much reliable detail as possible.

The efficiency engineer wants to know as to every item of work and fraction of hour whether standards are being realized, and if not, why not, so that conditions may be corrected.

Like a doctor, he may be more worried over a diphtheritic patch in the throat than over a broken leg, for a visible inefficiency may be less dangerous than some insidious, almost invisible inefficiency that is sapping the life of the whole plant.

The manager is interested in knowing as to each

item, each man, each machine, each operation, each department, each shop, the losses in material, money and time that are occurring, so that he, with the best advice he can secure, can stop them.

In industrial accounting the same absolutely reliable, immediate, adequate and permanent record must be good——

For the controller, to show him where the money goes.

For the efficiency engineer, to show him where standards are not realized.

For the manager, to show him where his losses are occurring.

It is possible to meet all these requirements with less clerical work, less clerical expense than is required for the usual systematized records.

A book printed from standard type contains less errors than an old manuscript written by a scribe who made each letter to suit himself and the spelling to match. If standard units of time and of cost of work are obtainable, we are approaching the conditions of the modern printer; but the records of most plants are made on the basis of the ancient scribes.

Use of Requisitions

An operating business carrying on work needs materials both for supply and maintenance and for operation. How does a depositor withdraw his money from a bank? By a check. This is a requisition on the bank, a voucher in its possession that

the money has been paid; the check stub is a memorandum to the check signer that he used the check for a particular purpose, the returned check is proof that he did so.

An individual plant can and should requisition materials exactly as a depositor checks out moneys, namely, as they are used—a separate requisition for each kind of money and for each payee.

A bank would be surprised if several depositors issued a joint check for two dollars and forty cents, one pound, six shillings and four pence, eight francs and sixty centimes, twelve marks and forty pfennigs payable to John Jones, Richard Roe and Nancy Perkins. Yet requisitions like several or all of these vagaries are the rule rather than the exception in operating records.

A separate specific requisition on a storehouse for each kind of material for each order, no more trouble than a check, is a receipt for the materials withdrawn. The requisition must state definitely the quality, price and quantity; also the order to which the issue is to be charged; and it must be signed by some one authorized to make the requisition. It is evident that if the storehouse holds an official requisition showing quantity and price as a receipt for every item of material issued, these requisitions can be sorted to each kind of material and also to each order and to each operation. Any minuteness of detail wanted can be embodied in each requisition.

It is difficult to understand why a workman, per-

haps an illiterate person who would scarcely be trusted with a dollar bill not belonging to him and who would be given no access to a petty cash drawer, is in many cases allowed to help himself without authority or receipt to materials worth thousands of dollars, which he indeed may not appropriate to his own use, but nevertheless may flagrantly waste. I recall one instance in which over $8,000 was lost in this manner.

The material requisition as outlined will give the storekeeper all the facts he needs and from it also the controller can obtain all the money facts he needs.

This device of requisition is very old, but modern efficiency accounting has enormously extended its usefulness. Not only is it now used, first for the issue records, but second, to support the standards of the efficiency engineer, standards of quantity and cost; third, the card is used for the efficiency records as to each item of material.

In addition, the card may be used for the following purposes:

To show the predetermined standard as well as actual charges against any account.

To show the comparisons in issues for the same purposes at different times.

To show the grouped and analyzed totals of each issue of each class of material.

The original card is therefore evidently issued in manifold, as many as necessary being made at one writing. A material requisition card contains many items. Some of them are printed, others require

for completion only a number, amount or name. No entry is made on a requisition card that is not needed somewhere at some time.

The use of this kind of requisition does not add to clerical work. No record is made on any card that ought not to be made at some time or other. The longer time required to make out a separate requisition for each kind of material for each order is offset by the gain in using a manifold card which serves several purposes. The items of entry may be infinitely varied or may be frequently changed. The business is not run to suit the card, but the card is adapted to the business.

These requisition cards, or service cards as they are technically called, take the place of many other records. No transcription is necessary, merely summaries, and as all the different sortings are of original entries, the chances of error are remote.

If the controller demands a classified statement of all the issues of the month, he will find one set of cards already so sorted. If he next demands a statement of the orders to which all these issues were made, he will find the duplicate set of cards already sorted to the orders. The two totals must agree not merely to a dollar, or to a dime, or to a cent, but to a *mill*.

This fundamental record made at the time of the issue, is reliable, immediate, adequate and permanent; it therefore fulfils all the requirements of the efficiency principle as to records. This record is moreover flexible. It lends itself to any degree of

refinement. A master mechanic might, for instance, draw by one order all his supplies of belting for a year, this being at once subdivided into twelve equal monthly requisitions, the amount being compared with a monthly standard allotment. Or if detail is wanted, requisitions may be made even for such small items as lead pencils. The degree of refinement does not depend on the article but on the importance of the total issue in the year. A ride in the subway in New York costs only five cents, but it is just as necessary to buy a ticket—to present a requisition, for this is all a ticket is—as if the journey were to be around the world. 200,000,000 subway rides in a year aggregate $10,000,000, and a possible shrinkage of even one per cent is very serious.

The Requisition System Extended

Materials are only one main class of expense, the other two being Personal Services and Charges. Why should not requisitions also be applied to Services and to Charges so as to have the same evidence, the same general control of all expenses?

Logically, from the viewpoint of cost and especially from that of efficiency improvement, a universal control is necessary; and the form of control that so admirably meets the requirements as to material issues also meets the requirements as to labor issues and charge distributions.

The storekeeper may be worried as to materials

but not as to labor; a superintendent may be concerned about pay-roll but not about materials used; a president may be interested in fixed charges, but not know about either materials or labor; but the general manager is concerned as to all three. He justly expects the efficiency of each to be one hundred per cent, but this is attained only when standard efficiency of each of the four terms of a dependent efficiency sequence is attained.

There must be one hundred per cent efficiency of price, one hundred per cent efficiency of supply, one hundred per cent efficiency of distribution, one hundred per cent efficiency of use.

If each of these four items shows an efficiency of only ninety-five per cent, the end result is eighty-one per cent; if each of the four items shows ninety per cent, the end result is 65.6 per cent; if each of the items reaches no higher than eighty per cent, the end efficiency is only forty-one per cent. If by any chance the four efficiencies should each be only fifty per cent, the end efficiency is a little higher than six per cent.

Neither is it to be imagined that a low efficiency can be averaged up by making one of the other efficiencies higher. It is very easy to drop from one hundred per cent to seventy-five per cent; it is extremely hard to increase efficiency to one hundred and twenty-five per cent, but even if the lost twenty-five points on one efficiency were offset by raising the other to one hundred and twenty-five per cent, the end result is only 93.75 per cent.

One hundred per cent efficiency as to each term of the sequence for each item of materials, of labor and of charges, is not enough. Materials, labor and charges must be so combined as to realize the lowest combined cost.

A combination based on the assumption of a charge efficiency of one hundred per cent becomes ruinously expensive if the charge efficiency sinks to thirty-three per cent. Give a man less food than he requires, he will inevitably starve to death—but operate a plant with less output than it was designed to deliver; it will in time go under.

How delicate and important becomes the work of setting standards and of making the plans that will realize them!

Everything that has been said of material requisitions applies also to labor requisitions.

If, for instance, a thousand post holes are to be dug, efforts should be made to determine:

(1) The rate of pay per hour for each man.

(2) The number of men to be engaged—standard of supply.

(3) The kind of man for each kind of work—standard of distribution.

(4) The standard time for each operation.

This may seem elementary, but outside of railroad train work there is usually only the vaguest check on any but the first of these four elements.

It is quite common to find a man employed at a higher rate than he is entitled to because he has a pull. Frequently more men are carried on the pay-roll than

ought to be there because of the general desire of some men to magnify their own importance by surrounding themselves with subordinates and thereby adding to the expenditures of their department. Economy means self-denial, while expenditures, whether for materials, men or equipment, involve the opposite. Again, specialized men on high wages are sometimes allowed to spend time on common work which ordinary labor could perform; and finally, partly because there are too many men, much longer time is given to each job than is necessary.

Reductions in number of men on pay-roll must therefore usually be promulgated from the president's office. The foremen, altho they may know perfectly well that there is labor surplus, rarely voluntarily recommend reductions.

Labor Requisitions

Instituting, therefore, similar requisition records for labor as for material, we might call a labor service card a voucher. No foreman should approve a pay-roll without putting in a voucher for each separate item of work in each order. This should not be a vague blanket voucher: "John Doe, $18 for a week's work." What work? How do we know there was any work? How do we know that John Doe was paid $18. How do we know that there was any John Doe? A year, two years hence, how can such an entry be certified to as correct? If we try to investigate, it is too often the case that the only

verifiable item is the missing $18. It makes no difference whether a direct money swindle was perpetrated and John Doe was wholly fictitious or whether a swindle in equivalency was perpetrated and the work was fictitious. In fact, the latter swindle is the more dangerous. There is a direct command against stealing, and the community has been fairly well trained to regard theft of money as wrong; but theft of time is not punishable by imprisonment. It takes a clever and bold rascal to pad a pay-roll ten per cent, but very honest and worthy foremen not only may, but continually do, allow gangs of men under them to waste two-thirds of the time. For one dollar lost by dishonesty there is probably one thousand dollars lost by failure to secure the equivalent.

To obviate uncertainty, to provide a record of equivalents, there is a labor service card for each item in each order, and the predetermined standards of time and costs should be stated as well as the record of the actual time and costs.

Common sense governs always. If there is a single order from the office to make twenty-four gear wheels, eight for one customer, four for repairs and twelve for stock; if there are two men working on two machines each, on four operations, there will be in all twelve dispatched labor requisitions, because there are four different machines involved, and on each machine, work for a customer, work for the repair department and work for the stock room.

FORM NO.	SERVICE CARD	(FIRM NAME)	
DATE	EMPLOYEE'S NO.	NAME	ORDER NO.
DEPT.	MACHINE	PART NO.	PIECES: WANTED / FINISHED
SCHEDULE	ST'D TIME (PER UNIT)	ST'D TIME (TOTAL)	

				RATE	AMOUNT				OPERATION
TIME FINISHED			W						
TIME STARTED			B						
TIME ELAPSED			T						

O. K

FOREMAN

DIAGRAM X

Diagram X shows a sample labor service card.

The minimum number of personal service cards to be issued in a pay-roll period is one per day for each person on the pay-roll; the maximum number should not usually exceed an average of five a day. Yet many more might be desirable. Assume a boot black stand. Four boys are on duty twelve hours; it takes four minutes to polish a pair of shoes. If all worked at the rate of five minutes to the shine, there ought to be 576 shines in a day, giving a revenue of $28.80. There is only $10 in the till in the evening, of which $5.76 is paid in wages ($0.12 an hour) and $2 for rent of location, leaving $2.24 in profit. There were only 200 paid shines.

An individual time ticket method is installed, one ticket for each shine, showing hour and minute

of its start and finish, a different colored ticket for each boy. At the day's end there is again $10 in the till and there have been expense and trouble securing the records. But these records permit, as never before, an analysis of the situation. It is revealed that one boy made eighty shines, another sixty, the third forty, and the fourth only twenty. The cards are next grouped by hours. It appears that eighty shines were made before nine o'clock and another eighty after five o'clock, the remaining forty being distributed over the intervening eight hours. Three boys are employed at $0.15 an hour. They make ninety-six shines before nine o'clock, and ninety-six after five o'clock. One of the three boys is busy all day, the other two go to school between nine o'clock and five o'clock. Under this arrangement the number of shines drops to 180; wages drop to $3, altho the rate per hour has risen twenty-five per cent; rent is still $2; and added expense for records is $1; total, $6; leaving $3 for profit.

The reliable, immediate and adequate records are not only useful in planning standards; but they also enable the manager to attain standards.

Without requisitions or vouchers or service cards checked against standards, it is not possible to tell what is happening In a single concern I have known of over-issues of material of $200,000 in a single year. Owing to the absence of standards the annual unnecessary loss in the United States probably exceeds $8,000,000,000.

Scheduling

To avoid labor wastes and labor inefficiencies, it is necessary to plan in advance, even as a woman plans a dinner party in advance. An advance labor voucher or service card packet is made out for each separate job of work in each order for each man, and the packet is placed on the dispatching board. A dispatch board is the visible implement and record of the planning. Each card contains the schedule both as to standard time and hourly cost of the item of work to be dispatched. This time determination of the work is called scheduling. It is evident that the time of a schedule depends on the material, on the equipment, on the operator, and on the administration.

It is also evident that no schedule can be permanent unless material, equipment, operator and administration have reached an unvarying condition. If hard steel is substituted for soft brass, a new schedule must be drawn up; if a new $10,000 tire lathe is substituted for a ramshackle tire lathe, twenty years old, a one-hour schedule may be properly substituted for a three-hour schedule. If in the course of his teaching, an apprentice is put on a man's job, a lengthened schedule ought to be given; if the administration provides lots of one hundred instead of lots of one and two, different and shorter schedules, in proportion, may be made for the more numerous lots. There has been so much crudeness in the past with regard to the fixing of piece rates, that a feeling has grown up among both workers and fair minded

employers that a schedule should never be changed.

This is wholly erroneous. A schedule should never be unfairly changed nor should either party assume the right to dictate what a fair schedule is. It is the material, the tool, the machine and the conditions that primarily determine the fair time of the schedule. The worker is employed to direct and supervise the work and to cut out unnecessary wastes. He is not paid wages or given a bonus to overstrain or overwork.

Schedules may have some permanence, but a few are emergency schedules, and these require special attention, care and supervision.

Dispatching

The act of issuing one copy of the work order or voucher or service card to the worker constitutes the act of dispatching. A glance at the dispatch board shows what each man is working on, when he is due to finish the job, and what work is then available for him.

It is to be presumed that the machine with which the man is to work is at its place, in good order, that the necessary tools in proper condition are there, and that the piece to be worked is on hand. If, for example, the man is a machinist, his procedure is analogous to that of the locomotive engineer who is called to appear at the round house at 1 a. m., who finds the locomotive with steam up, coal and water in tender and the train made up,

ready to be taken. Scheduled to start at 1.15 a. m. the engineer is expected to run the train thru on schedule time.

Vouchers for Fixed Charges

Even as materials and as labor are issued against receipts or vouchers, so also should fixed charges be evidenced by vouchers. If accounts are closed daily, as in a bank, then there must be daily charge vouchers; if accounts are closed weekly, then vouchers each week are sufficient; if accounts are closed monthly, monthly vouchers are sufficient for such items as taxes, insurance, depreciation and interest.

Sorting the Vouchers

Only the first, tho the most important, step either toward efficiency or toward reliable costs for individual items has been taken when every separate item of expense is covered by a voucher, such vouchers, properly distinguished, falling into the three divisions of materials, labor, and charges.

The next step consists in sorting all the requisitions into seven classes, which may be considered as seven boxes or drawers. Material requisitions are sorted to a box labeled Direct Materials of Manufacture or to one of the four indirect boxes, labeled, respectively, Power, Maintenance, Supervision, Rent. All the Material requisitions are now scattered into the seven boxes. Coal, for instance, is generally charged to Power, and the coal requisitions are to be

found in the "Power" box; issues of small tools are charged to Maintenance; office supplies are charged to Supervision; and floor polish or wall paper are charged to Rent.

The personal service vouchers or service cards are similarly distributed either to the box labeled Direct Labor or to Power, to Maintenance, to Supervision or to Rent. The wages of engineers, stokers, etc., are charged to Power, the pay for any item of maintenance labor is charged to Maintenance. Since "Time" is the unit and not the man, the units of time of the same man, as he does different jobs on the same day, may be distributed, part to Direct Labor, part to each of the four indirect classes. The whole time of very many employes, the office and supervising force is generally distributed to Supervision. Any time given to the items of taxes, insurance, depreciation or interest is properly chargeable to Rent. The charge vouchers are distributed either to the box labeled Direct Charges or to Power, or Maintenance, or Supervision, or Rent. Machines are just as much direct workers as materials or men, therefore the direct machine rate is made up of the proportional amount of taxes, insurance, depreciation and interest allotted to each machine. This total constitutes the machine's wage just as much as the direct pay of a worker is his wage. All the vouchers for all materials, all labor and all charges have as a second step been redistributed to the seven classes of

	Symbol
Direct Materials	Q P
Direct Labor	T W
Direct Equipment	t R
Power	Power
Maintenance	Maint.
Supervision	Suprn.
Rent	Rent

Q P stands for quantity of Materials multiplied by price per unit.

T W stands for total time in hours of workers multiplied by average rate of pay per hour.

t R stands for total time in hours of machines multiplied by average machine rate per hour.

Utilizing the Efficiency Records

We now have both an elementary efficiency record and an elementary cost record. Each single service card carries its own efficiency record, since it contains both the statement of predetermined standard and of actual performance.

If, therefore, we sum all the material cards as to standard and also as to actual costs of issue, we have not only the average material efficiency, but we can from the right cards pick out each separate itemized inefficiency. If the inefficiency of direct materials amounts to $200,000, we may first have to collect into convenient summaries the many separate record cards, but what is not usually understood is that no manager is expected to pick and nag at the records

on individual cards any more than the president of the Interborough in New York is expected to stand guard and count every passenger going thru every wicket. The summaries of the cards indicate where looseness is. If the power plant consists of a 100 horse-power engine running twelve hours a day, which on standard practice ought not to use over 3,600 pounds of coal a day, and there is actually requisitioned, as shown by service cards, 4 tons or 8,000 pounds, it is time to investigate. If there are 200 incandescent lights in the plant, each bulb guaranteed for 900 hours, and used three hours a day, yet 200 new bulbs are requisitioned each month, it again is an occasion for investigation. The president's standards are always, as far as possible, on the largest units, materials, labor, charges, for a given output; the manager's standards are on the three direct classes and on the four indirect classes.

Each foreman's standards are as to the six classes in his own department, direct materials being under a separate foreman as custodian.

If the general manager is aroused, as he ought to be, over the lamp issues, he can at once subdivide them among the foremen and pounce on the waster, who in turn, owing to the records, can find out who drew each separate bulb.

A more effective way, however, is to hold responsible for direct material issues a material supervisor. It ought not to be a $9 a week boy, it might well be an organization costing $20,000 a year if it is able to wipe out the $200,000 of waste.

The extent is remarkable to which men at the head of big concerns will permit continuous large wastes rather than incur a fractional expense to stop them. On one occasion an investigation revealed that $5,000 of lagging would prevent $50,000 of steam condensation losses. The expenditure was not permitted on the ground that no one would object to the coal wastes but everybody would balk at an expense for improvement.

Supervision

As all expenses are subdivided into seven classes, it is easy to appoint seven competent supervisors of efficiency, one for each class, and hold them responsible for complete information and remedial plans. If the plant is small, one man may fill several positions or a combination man may be appointed; the bookkeeper, for instance, may also be supervisor of rent charges; the chief engineer also supervisor of power and maintenance.

These supervisors do not interfere with the authority of the foremen. As supervisor of labor I may have determined that a fourteen-year old boy can go after the mail and small express packages three times a day to the two-mile distant village office, but if the foreman chooses to send a dozen able-bodied machinists to fetch one twist drill and they put in half a day doing it, that is his privilege. Planning, however, requires that he shall specify the task and the men on it in advance; that they

shall be dispatched and that their actual performance shall be checked up against the schedule.

Under these checks you can trust the foreman not to encourage inefficiencies, every one of which is recorded. The conscientious foreman welcomes and the careless foreman needs the help the records give him.

So far as efficiency is concerned, the records need go no further. If the seven classes of expense divided to each department have each reached one hundred per cent efficiency, costs are as low as they can be, unless there is a change of design, of materials, of machines, of equipment, of labor.

Costs

There are as yet no specific costs. Therefore, if the manager asks how much a particular item costs, he cannot be told. We know, indeed, the direct charges, but we do not know the amount of indirect charges to be apportioned to the item.

This is, however, decidedly important—so important that for the last fifty years cost accountants have been trying to distribute actual costs to each item. This is wrong because one of the greatest single items of cost and the most easily lessened is inefficiency. Actual costs are accidental, real costs are the standard costs with the inefficiency added.

Specific standard costs are important because in no other way can we compare the cost of one operation with another and select the better. Many an

owner has re-equipped his plant with expensive machinery in order to lessen costs, when in reality his trouble was inefficient use of what he had. Many an owner has invested in an expensive machine with an hourly rate of $2 working a little faster, when an inexpensive machine with an hourly rate of $0.30 would have done the work in twice the time.

Specific actual costs are important in order to know whether the selling price gives a profit or a loss, and also so as to know how to charge specific actual expense of each item to each order. Proper specific actual costs are not accidental costs which are variable, but are standard cost with inefficiency cost added.

To ascertain specific costs whether standard, or accidental, or actual, it is necessary to convert the indirect expenses of Power, of Maintenance, of Supervision and of Rent to burden expenses on Direct Materials, on Direct Labor and on Direct Charges. The first step is to subdivide the plant into its departments. The direct vouchers of labor and charges originate in departments, but we also apportion the total of Power, of Maintenance, of Supervision and of Rent to each department.

Power can be metered at a fixed rate per horse-power hour used, but this is not always easy. Assuming the whole expense of Power has been brought up to one hundred per cent efficiency, it is sufficiently accurate and generally much more practical to estimate the power consumption of each department and charge for the estimated amount. Whether

metered or guessed at, power is allotted on basis of horse-power hour.

Total rent charge is divided by total number of square feet of floor space in active use, and on the basis of this unit cost per square foot a charge is made against each department.

Supervision is, wherever possible, directly charged to a department, but all indirect supervising expenses are distributed to departments on the arbitrary basis of total pay-roll and total value of equipment.

Maintenance charges can be subdivided to each department or can be distributed on pay-roll and on machine valuation. *Minute accuracy in distributing indirect expenses is not essential.* If, for instance, Maintenance has been brought up to one hundred per cent and it is revealed that boring mills cost less to maintain than lathes, then it would be legitimate to assess a higher standard maintenance charge against a department using lathes than against one using boring mills, but if in the same department with two similar lathes, one is inferior and the other good, the difference in operating cost is not standard, but accidental and calls for no variation in rate.

Having subdivided each class of indirect charges to each department, materials being a separate department, inside of the department we subdivide each class to direct labor and to direct equipment.

Power for light, heat, washing water, for small air tools, etc. is assessed to men; Power for running machines is assessed to machines. Rent is appor-

tioned to men and equipment on basis of floor space. Supervision is apportioned on basis of pay-roll and of inventory value of equipment, maintenance for small tools and buildings is assessed to men on basis of pay roll, maintenance of machines is on basis of the inventory value of machines.

Many people strain at a gnat and swallow a camel. This trait is often manifested in the details of cost distribution. If any one prefers or considers more accurate some other basis for the distribution of Power, of Maintenance, of Supervision, of Rent to departments and within the departments to direct workers and to direct machines, let him adopt it. But let it be remembered that a twenty per cent, sometimes eighty per cent, efficiency loss deserves far more consideration than a half of one per cent difference arising from a more troublesome way of making the distribution.

Having distributed our material expenses to departments, we can sum up the indirect charges against materials as a whole, per dollar or per unit of quantity and against man-hours and machine-hours in proportion to man's and machine's rate.

We can now construct a universal cost formula. All costs can be stated as to every item from the head of a pin up to all the costs of the United States Government for a decade, under six heads:

Direct Materials	Q P
Direct Labor	T W
Direct Charges	t R

Burden on Materials	$Q\ B_p$
Burden on Labor	$T\ B_w$
Burden on Direct Charges	$t\ B_r$

The cost formula takes the form:

$$\text{Cost} = Q\ (P + B_p) + T(W + B_w) + t(R + B_r)$$

$$\text{Actual Cost} = \text{Actual}\ [Q\ (P + B_p) + T(W + B_w) + t(R + B_r)]$$

$$\text{Standard Cost} = \text{Standard}\ [Q\ (P + B_p) + T\ (W + B_w) + t\ (R + B_r)]$$

$$\text{Efficiency} = \frac{\text{Standard Cost}}{\text{Actual Cost}}$$

$$\text{Actual Cost} = \frac{\text{Standard Cost}}{\text{Efficiency}} = \frac{\text{Standard } Q\ (P + B_p) + T\ (W + B_w) + t\ (R + B_r)}{\text{Efficiency}}$$

On every material service card are the items Q P and Q B_p, both actual and standard.

On every labor service card are the items T W and T B_w, both actual and standard.

If machine costs are kept separate, on every machine service card are the items tR and tB_r.

If, as is often the case, machine rates are not separately indicated, then all of $t(R + B_r)$ is included in B_w, which is specifically determined for the operation, not for the man.

To determine the cost of any operation, all the service cards distributed to it are summarized. All the service cards can be issued like outstanding, but not presented, checks before the work is begun. Standard costs with average shop inefficiency added give the actual costs. If a manager for any reason prefers to use actual costs, he can wait until the work is done and have the summaries made for him.

The accumulated cost to date on any order can be ascertained at the end of any day. Therefore,

the total volume of work in progress, subdivided to all the different orders, can be given every single day.

Operating accounts become as reliable, as immediate and as adequate as the accounts of a National bank. The records are not so costly to maintain and operate as the usual records and they are vastly more accurate, infinitely more useful.

Harrington Emerson

UTL AT DOWNSVIEW
D RANGE BAY SHLF POS ITEM C
39 11 11 04 13 011 7